SKIN REACTIONS

XVII. The Stability of Glycerite of Hydrogen Peroxide on the Human Skin*

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Kretschmer (1) has described a new method of demonstrating surface patterns of the human skin by means of chemi-luminescence of hydrogen peroxide. According to Kretschmer, a 1.5 per cent aqueous solution of hydrogen peroxide is rapidly decomposed by the skin depending upon the catalytic centers distributed on different small areas of the skin. His technic consisted of placing photographic film directly in contact with the decomposing peroxide. He reported that he was able to get excellent patterns of catalyst distribution by developing the photographic film in the usual way following exposure to the decomposing peroxide. These studies stress the necessity of investigating the rate at which the normal and the diseased skin behave in connection with the decomposition of peroxide —a means often used to detect catalase in biological systems.

Ordinary aqueous peroxide does not have the property of forming films on the skin and remaining locally on the skin for a long period of time. The time elapsed is of importance for it is well known that peroxide must act for a suitable period in order to obtain its bacteriacidal effects. Since aqueous peroxide is difficult to distribute uniformly in a film on the skin, it seems more desirable to study the rate at which glycerite of hydrogen peroxide, which forms thin, more stable films of peroxide on the skin, is decomposed by the epidermal, decomposing agents of the skin.

Glycerite of hydrogen peroxide in recent years has been used by Brown and his coworkers for the local therapy of the skin and mucous membranes (2). It may be mentioned that glycerite of hydrogen peroxide is characterized by slow liberation of peroxide, presumably because of the extremely high coefficient of viscosity of the glycerine vehicle.

METHOD

Thin films of glycerite of hydrogen peroxide† were formed on the skin and the presence of peroxide was tested for periodically by absorbing some of the residual peroxide solution on the skin onto commercial starch iodide paper. The presence of glycerine retards the development of the typical blue reaction. However, a drop or two of water immediately develops the blue color on the paper indicating the presence of hydrogen peroxide. The intensity of the color and rapidity of the

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reaction provides a rapid technic whereby the presence of peroxide is shown. In general, sampling of peroxide on the skin was made every 10 or 15 minutes for 90 minutes.

Glycerite of hydrogen peroxide containing about 3 per cent of hydrogen peroxide and stabilized by 8-hydroxyquinoline† was applied by means of a calibrated pipette to the anterior aspect of the forearm, palms, and areas between the toes and over lesions of psoriasis. The solution was spread with the side of a dropper or glass rod so that between 0.1 to 0.2 cc. covered an area between 5 to 10 sq. cm.

Commercial starch iodide paper of the same batch was employed so that comparisons were possible. The sensitivity of the paper to peroxide was determined by diluting the glycerite of hydrogen peroxide with glycerine and determining the end point. This technic indicated that a faint blue color was brought out in a few minutes by 0.02 per cent of hydrogen peroxide. This then, approximately represents the concentration at which the starch iodide paper shows that most of the peroxide has either been destroyed or has evaporated from the surface of the skin.

DOES GLYCERINE INHIBIT THE ACTION OF PEROXIDE?

A typical experiment may be made to ascertain if the glycerite of hydrogen peroxide acted as a slow acting peroxide. Observations were made 1, 2, 5, 10, 20, and 30 minutes after a drop of glycerite of hydrogen peroxide was applied to two pieces of starch iodide paper. The color of starch iodide reaction on the paper which was moistened before the solution was applied. Within one minute the color reaction had occurred. On the starch iodide paper initially dry, only after 10 minutes did a faint color appear at the lower border of the droplet with more blue appearing after 30 minutes probably because of the absorption of moisture. At this time the color in the paper initially moistened had decreased in all liklihood due to bleaching. This experiment demonstrates well the slow action of glycerite of hydrogen peroxide. Another type of experiment was also designed to ascertain if peroxide acts slowly. Two drops of glycerite of hydrogen peroxide was applied to two equally dry pieces of starch iodide paper. After 15 minutes, the presence of a strong peroxide reaction was demonstratable when the back of the second piece of starch iodide paper was moistened. The water permeates the paper and the glycerine and thus accelerates the liberation of iodine by the peroxide.

THE STABILITY OF GLYCERITE OF HYDROGEN PEROXIDE ON THE HUMAN SKIN

A series of 8 normal adults, males and females in equal numbers were tested on the anterior aspects of the forearm to ascertain the length of time that peroxide could be readily detected by our method on the skin. In one series of experiments the skin was washed with aqueous 70 per cent propyl alcohol and compared with the other side. Figure 1 is representative of the data found in this series. Readily detectable peroxide was present on the anterior aspect of the forearm for at

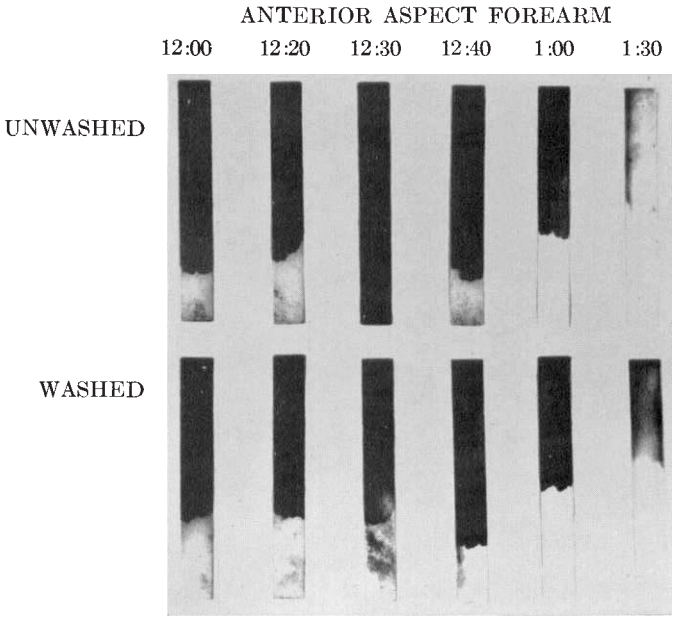

FIG. 1. The shaded areas represent the development of the starch iodide reaction due to the presence of peroxide on the starch iodide paper. Note that there is no essential difference between the rate of decomposition of the washed and unwashed surfaces. Note that peroxide is present longer than one hour.

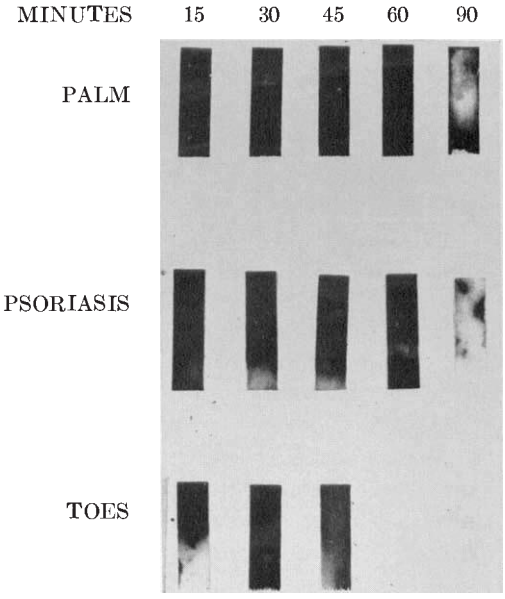

FIG. 2. The rate of decomposition of glycerite of hydrogen peroxide is accelerated between the toes but not by the lesions of psoriasis.

least 90 minutes. A strong peroxide reaction was observed for one hour. It must be recalled that these experiments were performed with *thin films* of glycerite of hydrogen peroxide. In all liklihood with therapeutic doses stronger reactions would have been observed at the end of 90 minutes. No difference was found between unwashed and washed forearms. It had been anticipated that sufficient catalyst might be present in the case of the unwashed forearm to greatly accelerate the decomposition of the peroxide. This was not confirmed.

Figure 2 shows that the palm of the hand decomposes the glycerite of hydrogen peroxide at very much the same rate found for the anterior aspect of the forearm. Applying a small amount of glycerite of hydrogen peroxide between the toes leads to a fairly rapid decomposition with, however, a readily detectable quantity remaining for 45 minutes. The glycerite of hydrogen peroxide was applied to large lesions of psoriasis and the results are illustrated in Figure 2. It was surprising to find that the psoriatic lesions did not decompose the peroxide to any great extent. The amount of peroxide detectable was approximately that found in the normal skin.

DISCUSSION

The results of these experiments indicate that thin films of glycerite of hydrogen peroxide form fairly stable reservoirs of peroxide both *in vitro* and *in vivo*. Not only is the viscosity of the glycerine involved but possibly other factors—involving reaction velocity which are catalyzed by moisture—may influence the persistence of peroxide. The conditions in normal skin between the toes, however, decompose the peroxide more rapidly. Whether or not high concentrations of glycerine may act to inhibit catalysis by forces other than those which prevent diffusion is a matter for future investigation.

The clinical applications of these findings may be illustrated by a remark of Fox and Shields[3] who recommend hydrogen peroxide as part of the therapy of impetigo contagiosa as well as those recommendations of Brown and his coworkers cited previously. Further, these experiments justify in particular the use of glycerite of hydrogen peroxide in various inflammatory aural conditions reported by Brown and Kelemen (4); Brown and Owen (5); and Aagesen, Brown and Weiss (6) by demonstrating the persistence of peroxide outside of purulent areas, i.e., a reservoir of peroxide is provided by the viscous glycerite.

What is not known is the exact rate at which the peroxide decomposes under our experimental conditions. In all likelihood the disappearance is a complex function of decomposition and evaporation of both H_2O and H_2O_2 and will probably not follow a linear course.

It is a well established procedure to use the decomposition of H_2O_2 to detect the presence of catalase (7). It would therefore be of interest to study the dermatoses with a view to detecting the presence of catalase by this technic. The fact that no more catalysts or decomposing agents other than normal are present on the surface of psoriatic lesions indicates that the technic described here may provide a simple procedure for assaying surface decomposition of hydrogen peroxide in the dermatoses.

SUMMARY

1. Activity of the human skin with respect to peroxide decomposition has been studied by means of films of glycerite of hydrogen peroxide. Peroxide activity in the films was followed by means of starch iodide paper.

2. It was found that in the normal human skin of the forearm peroxide activity remained in the films of peroxide for at least 90 minutes. Similar results were obtained in the palm of the hand and over psoriatic lesions. Decomposition was about twice as fast between the toes.

3. Thin films of glycerite of hydrogen peroxide formed fairly stable reservoirs of peroxide on the human skin but the rate of decomposition depends upon a complex number of factors including the viscosity of the glycerine, acidity, the presence of moisture, and the presence of catalysts like catalase. The method may probably be applied to the detection of catalase in the dermatoses.

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